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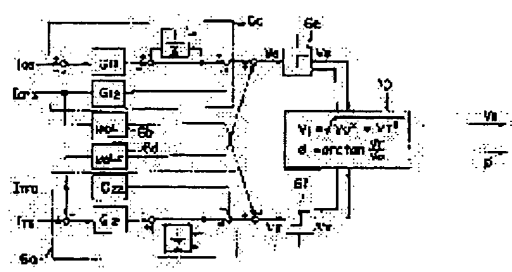
(54) VECTOR CONTROLLER FOR INDUCTION MOTOR

(57)Abstract:

PURPOSE: To assure a vector control state even if a DC voltage of a PWM inverter is lowered in order to vector-control an induction motor by the inverter having a current control system.



CONSTITUTION: Proportional integration control means 6c, 6a proportionally integrate current detected values IOFB, ITFB of exciting axis current command IOS and a torque axis current command ITS, interference term compensators 6d, 6b compensate them to obtain two-phase voltage commands VO, VT of a synchronous rotary coordinate system and a coordinate converter 10 obtains a primary voltage V1 of a motor and its phase ϕ from the voltages VO, VT. Limiters 6e, 6f limit the voltages VO, VT to limited values of a ratio of a voltage in the case of rating at the normal time, and when the voltages VO, VT tend to exceed the limited values, the previous voltages VO, VT are used as the limited values, and a coordinate conversion output by a primary voltage V1 and previous phase ϕ is obtained.

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CLAIMS

[Claim]
[Claim 1] Have a current control system by the proportionality integration operator from torque current command ITS of an induction motor, exciting-current command I0S, and each detection value ITFB and IOFB, and it asks for torque shaft voltage VT and the excitation shaft voltage V0 of a synchronous system of rotating axes. In the vector-control equipment which asks for the primary-voltage command V1 and phase angle phi of an induction motor by the coordinate transformation section from these voltages VT and V0, and carries out PWM control of the induction motor according to this voltage V1 and phase angle phi The limiter circuit which restricts the aforementioned torque shaft voltage VT and the excitation shaft voltage VO, respectively is prepared. Usually, sometimes, the aforementioned coordinate transformation section memorizes these voltages V0 and VT and phase angle phi while it fixes the limiter value of the aforementioned limiter circuit to the limiter value decided by the aforementioned excitation shaft voltage V0 and rated voltage of torque shaft voltage VT. Vector-control equipment of the induction motor characterized by obtaining a conversion output by aforementioned phase angle phi remembered to be these voltages VO and VT while the last voltages V0 and VT which carried out [aforementioned] storage are made into the limiter value of a limiter circuit, when the primary-voltage command V1 for which it asked the account of a front exceeds this limiter value.

[Translation done.]

DETAILED DESCRIPTION

[Detailed description]
[0001]
[Field of the Invention] this invention relates to the vector-control equipment which relates to the vector-control equipment of an induction motor, especially has a current control system.
[0002]
[Prior art] The vector-control equipment of the conventional example is shown in drawing 3 . The speed-control section 2 of an induction motor 1 obtains torque current command ITS from the deflection of speed-detection value omegaFB from speed command omega* and the speed detector 3 by the proportionality integration operator.
[0003] It slides from the secondary time constant (tau 2) of the exciting-current command IOS and the induction motor 1 made to intersect perpendicularly with torque current command ITS and this, and slides on the frequency operation part 4, and frequency omegaS is calculated.
[0004] Skid frequency omegaS is added with speed-detection value omegaFB of an induction motor 1, and it is changed into primary angular-velocity omegaO, and it integrates with this angular-velocity omegaO by the integration-operator section 5, and it is calculated as phase angle thetaO.
[0005] The current control section 6 performing the operation by the proportionality integration operator to torque current command ITS and the exciting-current command IOS from the deflection with each torque current detection value ITFB and exciting-current detection value IOFB, and subtracting and adding an interfered part in an induction motor to both the results of an operation further, it obtains torque shaft voltage VT and the excitation shaft voltage VO of a torque shaft of rotational coordinates.
[0006] The configuration of this current control section 6 becomes the operation block shown in drawing 4 . 6a becomes the proportional-plus-integral-control means of a torque current among this drawing, 6b becomes the 1st interference term compensation means, 6c becomes the proportional-plus-integral-control means of an exciting current, and 6d becomes the 2nd interference term compensation means.
[0007] The inside of drawing and omega 0 are for obtaining the vector current control which carried out non-interfering by considering as the control current equivalent leakage inductance, and G11 and G21 indicated G12, proportional gain, and 1/Z indicated [power angular frequency and L1 / the primary inductance of a motor, and Lsigma] the integration-operator term to be in integration gain and G22, and the interference terms 6b and 6d denied a part for the interference with mutual exciting-current IOFB and torque current ITFB within the motor.
[0008] It returns to drawing 3 and torque current detection value ITFB and exciting-current detection value IOFB are calculated from the two-phase-current detection value of an induction motor 1. This operation changes two phase currents IU and IW into digital value in the A/D-conversion section 7, respectively, by both addition, it also calculates the current detection value IV of V phase, is changed into the two phase alternating current of a fixed coordinate from each current values IU, IV, and IW by the three phase / two phase transducer 8, and changes this into torque current ITFB and exciting-current IOFB of rotational coordinates in the coordinate transformation section 9.

[0009] The armature-voltage control signals VO and VT which carried out non-interfering from the current control section 6 are changed into the voltage V1 of a polar coordinate, and phase angle phi, further, by the polar coordinate / three phase transducer 11, are changed into the three phase voltages VU, VV, and VW of a fixed coordinate by the coordinate transformation section 10, and are made the output voltage control signal of the PWM inverter 12.
[0010]
[Object of the Invention] In the conventional vector-control equipment, when carrying out an induction motor 1 to an electric vehicle drive and it uses power of the PWM inverter 12 as a battery, when the high current supply from a battery is made, direct current voltage EDC will be greatly changed by the internal impedance of a battery.
[0011] Thus, by the feedback control of a current control system, when the voltage EDC of DC power supply becomes lower than rated value, in order to acquire the output voltage command value V1 (motor primary-voltage command value) according to expected rotational frequency and torque, it is going to enlarge the value of control factor mu.
[0012] That is, the relation between the voltage command value V1 and control factor mu is the following formula [0013].
[A-one number] V1=(EDC/2) -mu ...... (1)
It is going to become and is going to obtain an expected thing on a voltage V1 by increase of control factor mu at a fall of direct current voltage EDC.
[0014] A voltage V1 is the following formula [0015] from the operation of the coordinate transformation section 10 of drawing 3 to the synchronous system-of-rotating-axes 2 phase-voltage command values VO and VT.
[A-two number] V1=(VO2+VT2) 1/2 ...... (2)
It is come out and asked.
[0016] By the way, PWM control must be performed and for acquiring a sine wave to the output current, the control factor mu must be 0 <=mu<=1. Therefore, the current control which restricted the voltage V1 so that it might become this domain is needed.
[0017] For this reason, when preparing a limiter in a current control system, it is restricted for [of voltage command value VT] both both [******, one side, or]. [the voltage command value VO for magnetic flux]
[0018] When the output voltage of a voltage V1 is restricted by the limiter and does not become an expected value at this time, the feedback currents IOFB and ITFB also become small. In this status, it becomes smaller than the command value IOS, integration term 1 / Z of a voltage VO will be saturated, and feedback current IOFB by the side of ****** to which only voltage VT by the side of torque is restricted first will also start the limiter of a voltage VO.
[0019] This phenomenon is explained with reference to drawing 5 . The place which should be in V1 (1) which becomes the angle phi 1 made with an excitation shaft, the synthetic vector V1 of voltages VT and VO will be suppressed by the vector of V1 (2), if voltage VT is restricted to the limiter value VTLIM. Moreover, if a voltage VO is restricted to the limiter value VOLIM after that, it will become the vector of V1 (3).
[0020] V1 [for example,] -- when VOLIM is the same as LIM, an angle phi 3 should be set to 3pi/4, and the position of a vector V1 must be the neighborhood of V1 (2) -- if a phase angle changes to the position of ** V1(3) ->V1 (2) a lot, the size |V1| will also change a lot, and an overcurrent will generate it in an induction motor
[0021] The purpose of this invention is to offer the vector-control equipment which also secures the vector-control status to a fall of the direct current voltage of PWM inverter.
[0022]
[The means for solving a technical problem] In order that this invention may aim at a resolution of the aforementioned technical probrem, it has a current control system by the proportionality integration operator from torque current command ITS of an induction motor, exciting-current command I0S, and each detection value ITFB and IOFB, and asks for torque shaft voltage VT and the excitation shaft

voltage V0 of a synchronous system of rotating axes. In the vector-control equipment which asks for the primary-voltage command V1 and phase angle phi of an induction motor by the coordinate transformation section from these voltages VT and V0, and carries out PWM control of the induction motor according to this voltage V1 and phase angle phi The limiter circuit which restricts the aforementioned torque shaft voltage VT and the excitation shaft voltage VO, respectively is prepared. Usually, sometimes, the aforementioned coordinate transformation section memorizes these voltages V0 and VT and phase angle phi while it fixes the limiter value of the aforementioned limiter circuit to the limiter value decided by the aforementioned excitation shaft voltage V0 and rated voltage of torque shaft voltage VT. When the primary-voltage command V1 for which it asked the account of a front exceeds this limiter value, while the last voltages V0 and VT which carried out [aforementioned] storage are made into the limiter value of a limiter circuit, it is characterized by obtaining a conversion output by aforementioned phase angle phi remembered to be these voltages VO and VT.
[0023]
[Operation] Replace with restricting the voltage command V1, and voltages VO and VT are restricted by each limiter circuit. This limiting value VOLIM and VTLIM is made into the limiter value usually decided by the rated DC-power-supply voltage EDC, the excitation shaft voltage V0 at that time, and rated voltage of torque shaft voltage VT sometimes. It is performing the limiter control restricted to the voltages V0 and VT just before exceeding, and also making a phase angle into a value last time, when the primary-voltage command V's1 exceeds a limiter value, and they are voltages V0 and VT. ** imbalanced occurrence is lost.
[0024]
[Example] Drawing 1 is the current control-block view showing one example of this invention. The fraction into which this drawing is different from drawing 4 forms limiter circuits 6e and 6f in the excitation shaft voltage VO and torque shaft voltage VT, respectively, and is in the point which controlled the limiter value of this limiter circuit by the coordinate transformation section 10.
[0025] Sometimes, the limiter circuits [these / 6e and 6f] limiter values VOLIM and VTLIM are usually [0026].
[A-three number]

$$V_{OLIM} = \frac{V_{OR}}{\sqrt{V_{OR}^2 + V_{TR}^2}} \times \frac{E_{DC}}{2}$$

$$V_{OLIM} = \frac{V_{TR}}{\sqrt{V_{OR}^2 + V_{TR}^2}} \times \frac{E_{DC}}{2}$$

[0027] However, EDC follows VOR, the DC-power-supply voltage of PWM inverter and VTR follow the voltages V0 and VT at the time of rating, and it is set up, and is decided from the proportion and the direct current voltage EDC of voltages V0 and VT.
[0028] and the time of becoming such a voltage output to this limiter value -- the coordinate transformation section 10 -- a limiter value -- a limiter -- the vector-control status of such a just before -- carrying out .
[0029] This changeover control is made into the procedure shown in drawing 2 . In this drawing, from the limiter circuits [6e and 6f] output voltage V0 and VT, the coordinate transformation section 10 memorizes the voltages V0 and VT at that time as PRV0 and PRVT while it asks for the primary voltage V1 of a motor, and phase angle phi. Moreover, phase angle phi at that time is memorized as phin (S1). The coordinate transformation section 10 judges after that whether this voltage V1 exceeded limiter value V1LIM</SUB> at the time of rating (S2).
[0030] When not exceeding a limiter value by this judgment, it is usually made the limiter value at the time (S3), and phase angle phin is set to last value phin-1 (S6), and a voltage V1 and phase angle phin

are outputted.
[0031] next, the time of a voltage V1 exceeding a limiter value -- output voltage V1 -- limiter value V1LIM -- correcting -- (S4) -- subsequently -- the limit value V0 of a limiter circuit -- while LIM and VTLIM are switched to the storage values PRV0 and PRVT of the voltages V0 and VT in the last operation, respectively, phase angle phin is switched to storage value phin-1 of last time (S5)
[0032] Moreover, when a voltage V1 escapes from a limiter, it is usually returned to the limiter value at the time at step S3.
[0033] Therefore, the limiter value by limiter circuits 6e and 6f Usually, he is in the limiting value sometimes calculated from the voltage V1 at the time of rating etc., and the current control by voltage and phase angle phi which the limiter restricted [the limiter] to the voltages V0 and VT of such a front by supply voltage fall etc. such at the time should do. Without inviting imbalance to the limiter value of voltages VO and VT also at the time of a fall of direct current voltage Edc, swinging can be lost to the phase angle of the synthetic voltage V1, and the vector-control status can always be secured.
[0034] Moreover, the labile of the control system when usually returning to a control which escaped from limiting value can be suppressed. That is, energizing voltage VO is a small fixed value, and torque voltage VT changes broadly and it becomes such a thing also to a limiter. Therefore, if it is the proportion which is called VOLIM<VTLIM, change of the phase phi 3 of the voltage V1 when starting a limiter becomes small, the amount of phase changes of V1 when escaping from a limiter can also become small, destabilization can be prevented, and the overcurrent of a motor can be prevented.
[0035]
[Effect of the invention] According to this invention the above passage, a limiter circuit is prepared in the energizing voltage VO of a current control system, and the operation of torque voltage VT, respectively. Since the limit and coordinate transformation output by the voltages V0 and VT and phase angle phi which are memorized at the time of the last operation were obtained when it considered as the value which usually doubled each limiter value sometimes at voltage VO at the time of rating, and VT proportion and a limiter value was exceeded, The vector-control status can be acquired also in the limit status of the voltages VO and VT by fall of the direct current voltage EDC of PWM inverter, the labile of a control system is abolished, and there are effects, such as an overcurrent protection of a motor.
[0036] Moreover, the labile of the control system when escaping from the operating state of a limiter can also be prevented.

[Translation done.]

MEANS

[The means for solving a technical problem] In order that this invention may aim at a resolution of the aforementioned technical probrem, it has a current control system by the proportionality integration operator from torque current command ITS of an induction motor, exciting-current command I0S, and each detection value ITFB and IOFB, and asks for torque shaft voltage VT and the excitation shaft voltage V0 of a synchronous system of rotating axes. In the vector-control equipment which asks for the primary-voltage command V1 and phase angle phi of an induction motor by the coordinate transformation section from these voltages VT and V0, and carries out PWM control of the induction motor according to this voltage V1 and phase angle phi The limiter circuit which restricts the aforementioned torque shaft voltage VT and the excitation shaft voltage VO, respectively is prepared. Usually, sometimes, the aforementioned coordinate transformation section memorizes these voltages V0 and VT and phase angle phi while it fixes the limiter value of the aforementioned limiter circuit to the limiter value decided by the aforementioned excitation shaft voltage V0 and rated voltage of torque shaft voltage VT. When the primary-voltage command V1 for which it asked the account of a front exceeds this limiter value, while the last voltages V0 and VT which carried out [aforementioned] storage are made into the limiter value of a limiter circuit, it is characterized by obtaining a conversion output by aforementioned phase angle phi remembered to be these voltages VO and VT.

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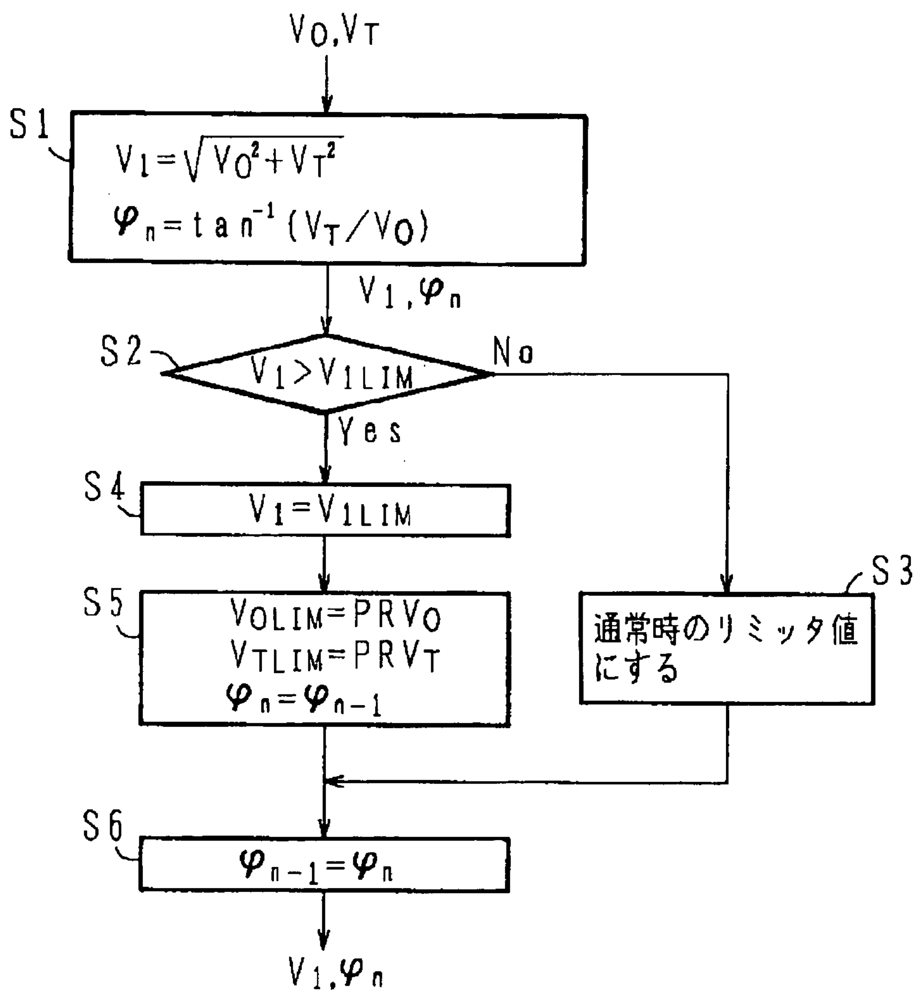
Drawing selection drawing 2

実施例のリミッタ処理手順図



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DESCRIPTION OF DRAWINGS

[An easy explanation of a drawing]
[Drawing 1] The current control-block view showing one example of this invention.
[Drawing 2] The limiter procedure view in an example.
[Drawing 3] The control-system block diagram of vector-control equipment.
[Drawing 4] The conventional current control-block view.
[Drawing 5] Drawing showing change of the voltage V1 at the time of a limit.
[An explanation of a sign]
1 -- Induction motor
6 -- Current control section
10 -- Coordinate transformation section
12 -- PWM inverter
6a, 6c -- Proportional-plus-integral-control means
6c, 6d -- Interference term compensation means
6e, 6f -- Limiter circuit

[Translation done.]

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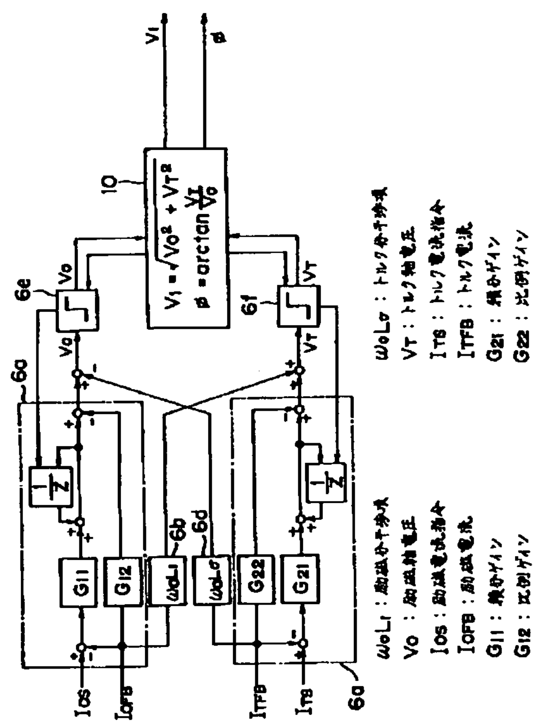
(54)【発明の名称】　誘導電動機のベクトル制御装置

(57)【要約】

【目的】　電流制御系を持つＰＷＭインバータにより誘導電動機をベクトル制御するのに、ＰＷＭインバータの直流電圧の低下にもベクトル制御状態を確保する。

【構成】　励磁軸電流指令I_{0S}とトルク軸電流指令I_{TS}と夫々の電流検出値I_{0FB}，I_{TFB}から比例積分制御手段６ｃ，６ａによる比例積分演算を行い、これに干渉項補償手段６ｄ，６ｂによる補償を行って同期回転座標系の２相電圧指令V_0，V_Tを得、この電圧V_0，V_Tから電動機の一次電圧V_1とその位相ϕを座標変換部１０で求めるにおいて、リミッタ回路６ｅ，６ｆによって電圧V_0，V_Tを夫々制限し、この制限は通常時には定格時の電圧V_{0R}，V_{TR}の比率になるリミッタ値とし、このリミッタ値を越えようとするときに前回の電圧V_0、V_Tをリミッタ値とし、また一次電圧V_1及び前回の位相ϕによる座標変換出力を得る。

実施例の電流制御ブロック図



【特許請求の範囲】

【請求項1】　誘導電動機のトルク電流指令I_{TS}と励磁電流指令I_{0S}と夫々の検出値I_{TFB}，I_{0FB}から比例積分演算による電流制御系を有して同期回転座標系のトルク軸電圧V_Tと励磁軸電圧V_0を求め、この電圧V_TとV_0から座標変換部によって誘導電動機の一次電圧指令V_1と位相角ϕを求め、この電圧V_1と位相角ϕに従って誘導電動機をPWM制御するベクトル制御装置において、
前記トルク軸電圧V_Tと励磁軸電圧V_0を夫々制限するリミッタ回路を設け、前記座標変換部は通常時には前記リミッタ回路のリミッタ値を前記励磁軸電圧V_0とトルク軸電圧V_Tの定格電圧で決まるリミッタ値に固定すると共に今回の電圧V_0、V_Tと位相角ϕを記憶しておき、前記求めた一次電圧指令V_1が該リミッタ値を越えたときに前記記憶しておいた前回の電圧V_0、V_Tをリミッタ回路のリミッタ値とすると共に該電圧V_0、V_Tと記憶する前記位相角ϕにより変換出力を得ることを特徴とする誘導電動機のベクトル制御装置。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、誘導電動機のベクトル制御装置に係り、特に電流制御系を有するベクトル制御装置に関する。

【0002】

【従来の技術】図3に従来例のベクトル制御装置を示す。誘導電動機1の速度制御部2は、速度指令$\omega *$と速度検出部3からの速度検出値ω_{FB}の偏差から比例積分演算によってトルク電流指令I_{TS}を得る。

【0003】トルク電流指令I_{TS}とこれに直交させる励磁電流指令I_{0S}と誘導電動機1の二次時定数（τ_2）からすべり周波数演算部4にすべり周波数ω_Sを求める。

【0004】すべり周波数ω_Sは、誘導電動機1の速度検出値ω_{FB}と加算されて一次角速度ω_0に変換され、この角速度ω_0は積分演算部5によって積分されて位相角θ_0として求められる。

【0005】電流制御部6はトルク電流指令I_{TS}及び励磁電流指令I_{0S}に対して夫々のトルク電流検出値I_{TFB}及び励磁電流検出値I_{0FB}との偏差から比例積分演算による演算を行い、さらに両演算結果に対して誘導電動機内の干渉分を加減算して回転座標のトルク軸のトルク軸電圧V_Tと励磁軸電圧V_0を得る。

【0006】この電流制御部6の構成は図4に示す演算ブロックになる。同図中、6aはトルク電流の比例積分制御手段になり、6bは第1の干渉項補償手段になり、6cは励磁電流の比例積分制御手段になり、6dは第2の干渉項補償手段になる。

【0007】図中、ω_0は電源角周波数、L_1は電動機の一次インダクタンス、$L\sigma$は等価漏れインダクタンス、G_{11}，G_{21}は積分ゲイン、G_{12}，G_{22}は比例ゲイン、1／Zは積分演算項を示し、干渉項6b，6dは電動機内で励磁電流I_{0FB}とトルク電流I_{TFB}の互いの干渉分を打消した制御電流とすることにより非干渉化したベクトル電流制御を得るためのものである。

【0008】図3に戻って、トルク電流検出値I_{TFB}及び励磁電流検出値I_{0FB}は誘導電動機1の二相電流検出値から演算される。この演算は二相電流I_U，I_WをA／D変換部7で夫々ディジタル値に変換し、両者の加算によってV相の電流検出値I_Vも求め、各電流値I_U，I_V，I_Wから三相／二相変換部8で固定座標の二相交流電流に変換し、これを座標変換部9で回転座標のトルク電流I_{TFB}と励磁電流I_{0FB}に変換する。

【0009】電流制御部6からの非干渉化した電圧制御信号V_0，V_Tは座標変換部10によって極座標の電圧V_1と位相角ϕに変換され、さらに極座標／三相変換部11によって固定座標の三相電圧V_U，V_V，V_Wに変換され、PWMインバータ12の出力電圧制御信号にされる。

【0010】

【発明が解決しようとする課題】従来のベクトル制御装置において、誘導電動機1を電気自動車駆動用にする場合など、PWMインバータ12の電源をバッテリとする場合、バッテリからの大電流供給がなされたときにバッテリの内部インピーダンスにより直流電圧E_{DC}が大きく変動することになる。

【0011】このように、直流電源の電圧E_{DC}が定格値よりも低くなるとき、電流制御系のフィードバック制御では所期の回転数・トルクに応じた出力電圧指令値V_1（モーター次電圧指令値）を得るために制御率μの値を大きくしようとする。

【0012】即ち、電圧指令値V_1と制御率μの関係は次式

【0013】

【数1】$V_1=(E_{DC}/2)\cdot\mu$　………（1）

となり、直流電圧E_{DC}の低下に制御率μの増大で電圧V_1に所期のものを得ようとする。

【0014】電圧V_1は図3の座標変換部10の演算から、同期回転座標系2相電圧指令値V_0，V_Tより次式

【0015】

【数2】$V_1=(V_0^2+V_T^2)^{1/2}$　………（2）

で求められる。

【0016】ところで、PWM制御を行って出力電流に正弦波を得るにはその制御率μは$0\leqq\mu\leqq1$でなければならない。よって、この範囲になるよう電圧V_1を制限した電流制御が必要となる。

【0017】このため、電流制御系にリミッタを設ける場合、磁束分の電圧指令値V_0とトルク分の電圧指令値V_Tのいずれか一方あるいは両方が制限される。

【0018】このとき、電圧V_1の出力電圧がリミッタで制限されて所期の値にならないとき、フィードバック電流I_{0FB}，I_{TFB}も小さくなる。この状態では例えば最

初にトルク側の電圧V_Tのみが制限されるも磁束側のフィードバック電流I_{OFB}も指令値I_{OS}よりも小さくなってしまい、電圧V_0の積分項1／Zが飽和して電圧V_0のリミッタにかかってしまうことになる。

【0019】この現象を図5を参照して説明する。電圧V_TとV_0の合成ベクトルV_1は励磁軸となす角ϕ_1になるV_1（1）にあるべきところ、電圧V_Tがそのリミッタ値V_{TLIM}に制限されるとV_1（2）のベクトルに抑えられる。また、その後に電圧V_0がそのリミッタ値V_{OLIM}に制限されるとV_1（3）のベクトルになってしまう。

【0020】例えば、V_{1LIM}とV_{OLIM}が同じであるときは角ϕ_3は3π／4となり、ベクトルV_1の位置はV_1（2）の近辺であるはずがV_1（3）→V_1（2）の位置へ位相角が大きく変化するとその大きさ｜V_1｜も大きく変化し、誘導電動機に過電流が発生してしまう。

【0021】本発明の目的は、PWMインバータの直流電圧の低下にもベクトル制御状態を確保するベクトル制御装置を提供することにある。

【0022】

【課題を解決するための手段】本発明は、前記課題の解決を図るため、誘導電動機のトルク電流指令I_{TS}と励磁電流指令I_{OS}と夫々の検出値I_{TFB}，I_{OFB}から比例積分演算による電流制御系を有して同期回転座標系のトルク軸電圧V_Tと励磁軸電圧V_0を求め、この電圧V_TとV_0から座標変換部によって誘導電動機の一次電圧指令V_1と位相角ϕを求め、この電圧V_1と位相角ϕに従って誘導電動機をPWM制御するベクトル制御装置において、前記トルク軸電圧V_Tと励磁軸電圧V_0を夫々制限するリミッタ回路を設け、前記座標変換部は通常時には前記リミッタ回路のリミッタ値を前記励磁軸電圧V_0とトルク軸電圧V_Tの定格電圧で決まるリミッタ値に固定すると共に今回の電圧V_0、V_Tと位相角ϕを記憶しておき、前記求めた一次電圧指令V_1が該リミッタ値を越えたときに前記記憶しておいた前回の電圧V_0、V_Tをリミッタ回路のリミッタ値とすると共に該電圧V_0、V_Tと記憶する前記位相角ϕにより変換出力を得ることを特徴とする。

【0023】

【作用】電圧指令V_1を制限するのに代えて電圧V_0，V_Tを夫々のリミッタ回路で制限し、この制限値V_{OLIM}，V_{TLIM}は通常時には定格直流電源電圧E_{DC}とそのときの励磁軸電圧V_0とトルク軸電圧V_Tの定格電圧で決まるリミッタ値としておき、一次電圧指令V_1がリミッタ値を越えたときには、越える直前の電圧V_0、V_Tに制限するリミッタ制御を行い、また、位相角も前回値にすることで電圧V_0、V_T。のアンバランス発生を無くす。

【0024】

【実施例】図1は本発明の一実施例を示す電流制御ブロック図である。同図が図4と異なる部分は励磁軸電圧V_0及びトルク軸電圧V_Tに夫々リミッタ回路6e，6fを設け、このリミッタ回路のリミッタ値を座標変換部10で制御するようにした点にある。

【0025】このリミッタ回路6e，6fのリミッタ値V_{OLIM}，V_{TLIM}は、通常時には

【0026】

【数3】

$$V_{OLIM} = \frac{V_{OR}}{\sqrt{V_{OR}^2 + V_{TR}^2}} \times \frac{E_{DC}}{2}$$

$$V_{OLIM} = \frac{V_{TR}}{\sqrt{V_{OR}^2 + V_{TR}^2}} \times \frac{E_{DC}}{2}$$

【0027】但し、E_{DC}はPWMインバータの直流電源電圧、V_{OR}，V_{TR}は定格時の電圧V_0，V_Tに従って設定され、電圧V_0、V_Tの比率と直流電圧E_{DC}から決められる。

【0028】そして、該リミッタ値にかかる電圧出力になるとき、座標変換部10がリミッタ値をリミッタにかかる直前のベクトル制御状態のする。

【0029】この切換制御は、図2に示す手順にされる。同図において、リミッタ回路6e，6fの出力電圧V_0，V_Tから、座標変換部10は電動機の一次電圧V_1及び位相角ϕを求めると共にそのときの電圧V_0、V_TをPRV_0、PRV_Tとして記憶しておく。また、そのときの位相角ϕをϕnとして記憶しておく（S1）。その後座標変換部10は、該電圧V_1が定格時のリミッタ値V_{1LIM}を越えたか否かの判定をする（S2）。

【0030】この判定でリミッタ値を越えてないときは通常時のリミッタ値にし（S3）、位相角ϕnを前回値ϕ_{n-1}とし（S6）、電圧V_1、位相角ϕnを出力する。

【0031】次に、電圧V_1がリミッタ値を越えたとき、出力電圧V_1をリミッタ値V_{1LIM}に訂正し（S4）、次いでリミッタ回路のリミット値V_{OLIM}とV_{TLIM}を夫々前回の演算での電圧V_0、V_Tの記憶値PRV_0、PRV_Tに切換えると共に、位相角ϕnを前回の記憶値ϕ_{n-1}に切り換える（S5）。

【0032】また、電圧V_1がリミッタから抜けたときはステップS3で通常時のリミッタ値に戻される。

【0033】従って、リミッタ回路6e、6fによるリミッタ値は、通常時には定格時の電圧V_1等から求められる制限値にあり、電源電圧低下等によりリミッタがかかるときにはリミッタがかかる前の電圧V_0、V_Tに制限した電圧と位相角ϕによる電流制御がなされ、直流電圧E_{dc}の低下時にも電圧V_0，V_Tのリミッタ値にアンバランスを招くことなく、その合成電圧V_1の位相角に揺れを無くして常時ベクトル制御状態を確保することができる。

【0034】また、制限値から抜けた通常制御に戻るときの制御系の不安定を抑えることができる。即ち、励磁電圧V_0は一定の小さな値であり、トルク電圧V_Tが広範

囲に変化してリミッタにもかかることになる。よって、$V_{OLIM} < V_{TLIM}$というような比率であればリミッタにかかったときの電圧V_1の位相ϕ_3の変化が小さくなり、リミッタから抜けたときのV_1の位相変化量も小さくなって不安定化を防ぐことができ、電動機の過電流を防止できる。

【0035】

【発明の効果】以上のとおり、本発明によれば、電流制御系の励磁電圧V_0とトルク電圧V_Tの演算に夫々リミッタ回路を設け、夫々のリミッタ値を通常時には定格時の電圧V_0, V_T比率に合わせた値とし、リミッタ値を越えたときに前回の演算時に記憶する電圧V_0、V_T及び位相角ϕによる制限と座標変換出力を得るようにしたため、PWMインバータの直流電圧E_{DC}の低下による電圧V_0, V_Tの制限状態にもベクトル制御状態を得ることができ、制御系の不安定を無くして電動機の過電流防止等の効果がある。

【0036】また、リミッタの動作状態から抜けるときの制御系の不安定も防止できる。

【図面の簡単な説明】

【図1】本発明の一実施例を示す電流制御ブロック図。

【図2】実施例におけるリミッタ処理手順図。

【図3】ベクトル制御装置の制御系構成図。

【図4】従来の電流制御ブロック図。

【図5】リミット時の電圧V_1の変化を示す図。

【符号の説明】

1…誘導電動機

6…電流制御部

10…座標変換部

12…PWMインバータ

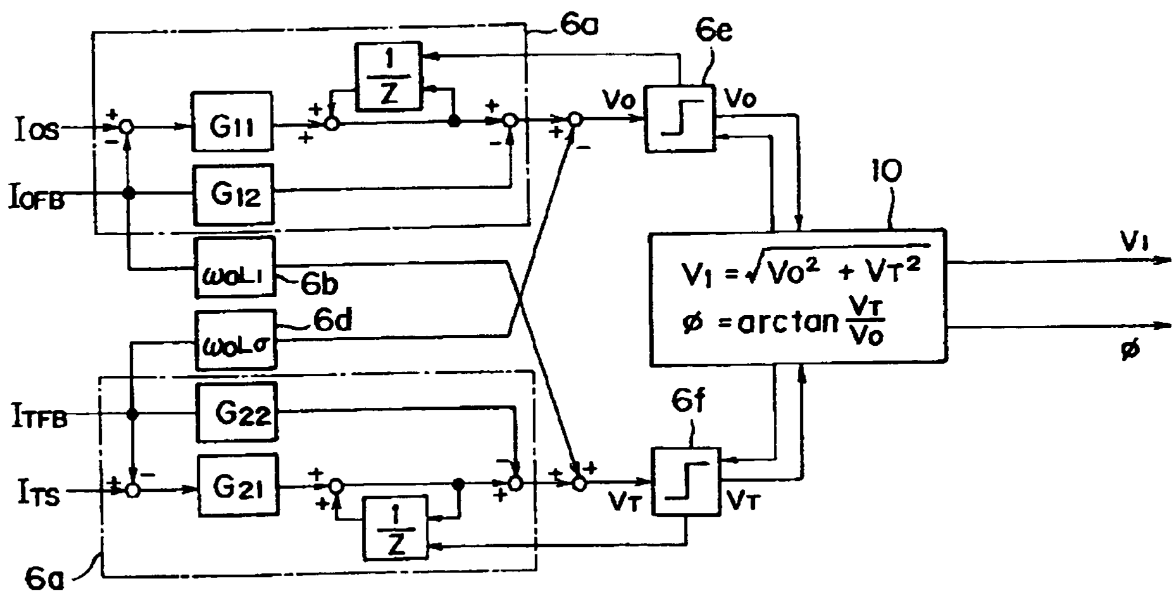
6a, 6c…比例積分制御手段

6c, 6d…干渉項補償手段

6e, 6f…リミッタ回路

【図1】

実施例の電流制御ブロック図



$\omega_0 L_1$：励磁分干渉項　$\omega_0 L_\sigma$：トルク分干渉項

V_0：励磁軸電圧　V_T：トルク軸電圧

I_{0S}：励磁電流指令　I_{TS}：トルク電流指令

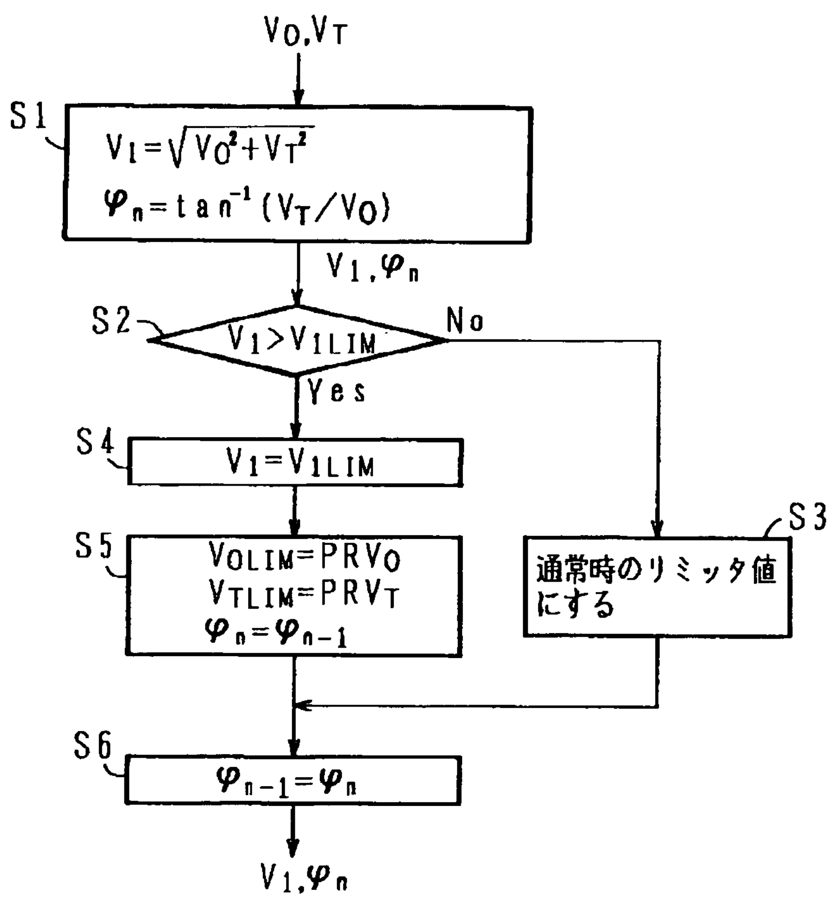
I_{0FB}：励磁電流　I_{TFB}：トルク電流

G_{11}：積分ゲイン　G_{21}：積分ゲイン

G_{12}：比例ゲイン　G_{22}：比例ゲイン

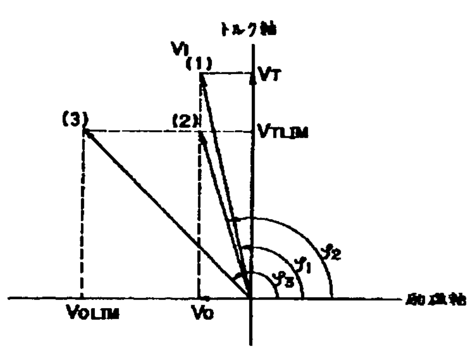
【図2】

実施例のリミッタ処理手順図

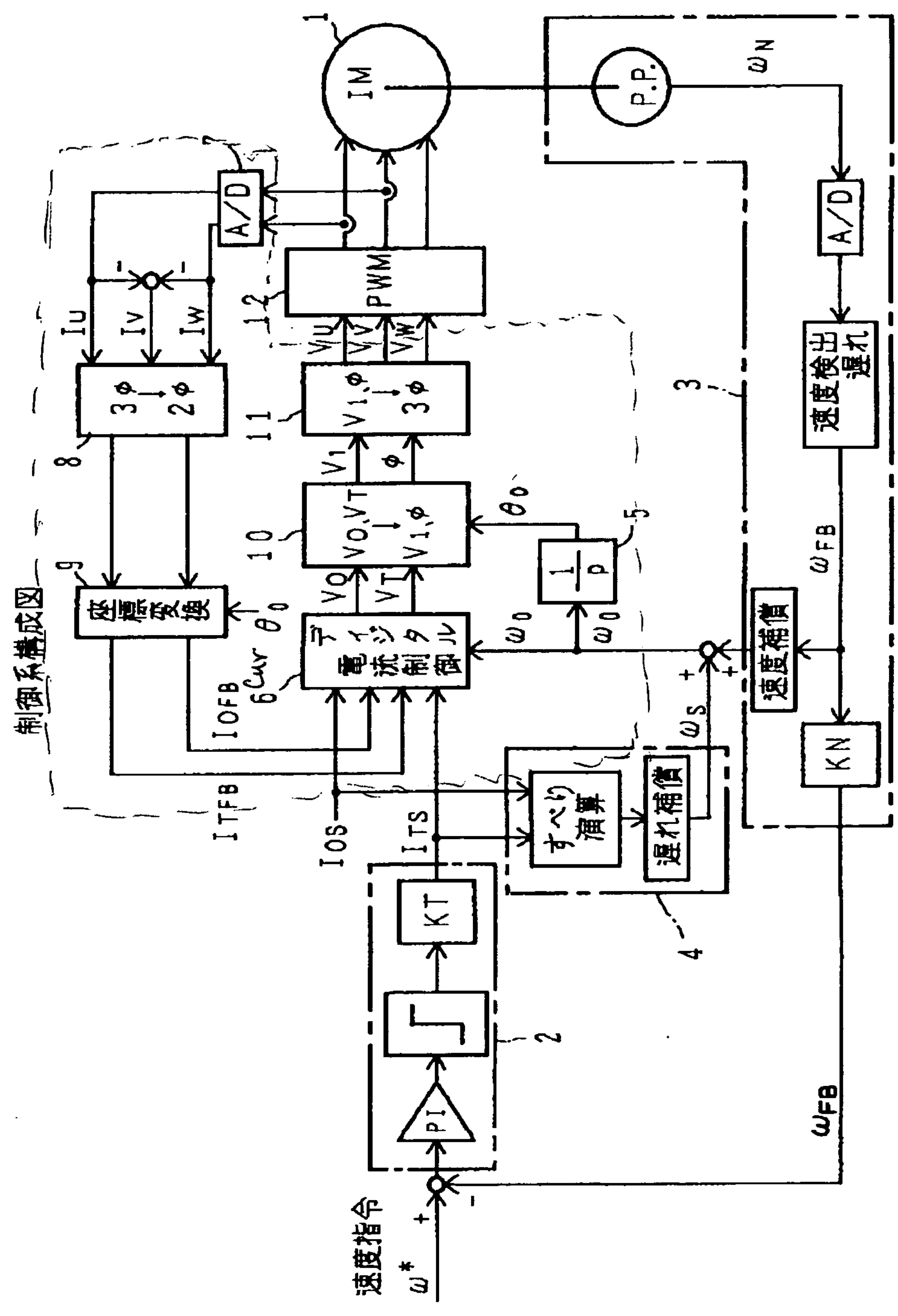


【図5】

リミット時の電圧 V1 の変化



【図3】

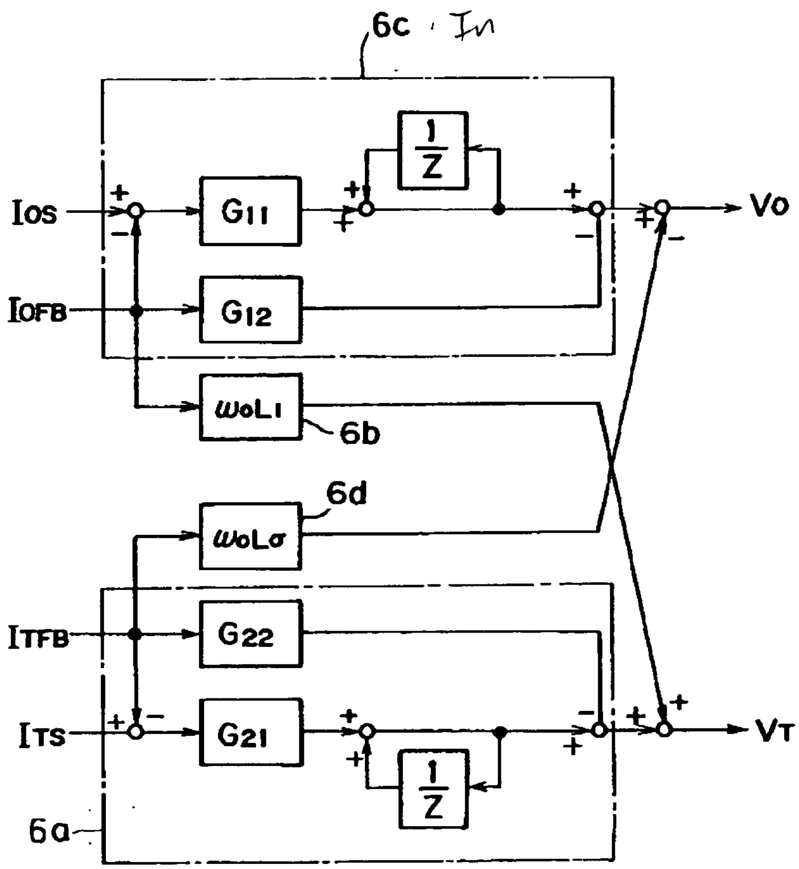


6 - Current Control Section
10 - Coordinate Transformation Section
12 - PWM inverter
9 - Coordinate Transformation Section

【図4】

従来の電流制御ブロック図

⑥



6c, 6d – Interference term compensation means

6e, 6f – Limiter Circuit

6a, 6c – PI controller